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Digital technologies and the biomedicalisation of everyday activities: the case of walking and cycling

Abstract

Walking and cycling have been transformed by digital technologies, which range from mapping apps for way-finding, through 'wearables' which monitor activity, to social media apps for comparing activity within social groups. Some technologies are explicitly orientated to health projects, others are not, yet all have potentially profound effects on bodies, health-orientated identities and understandings of health.

This paper uses the concept of biomedicalisation to explore emerging literature on the intersection of digital technologies with everyday mobility, focusing on walking and cycling. Beyond simply 'medicalising' mobility (by bringing it into the realm of public health), digital technologies contribute to various transformations of health: encouraging some health practices, inhibiting others; creating or excluding individual and collective health-related identities; and reconfiguring health and wellbeing. There is research evidence on the contingent and multiple relationships between digital technologies and social practices, with specific themes including: quantification; the role of apps in framing walking as extraordinary, cycling as competitive; enabling users to perform as healthy, neoliberal citizens; and digital careers. There has been less attention on how social divisions are reproduced or disrupted by the mediation of mobility through digital technologies. Further research should consider the impact of digital technologies on political economies of health.

Words: 5500

Introduction

Although the therapeutic benefits of physical activity have long been extolled, recent concern with increasingly sedentary lifestyles has contributed to the emergence of a medicalised field of 'active travel', in which everyday mobility has been reframed as a public health problem, requiring 'interventions' to increase the amount of walking and cycling in the population (Green, 2009; de Nazelle et al., 2011; Saunders et al., 2013; Oja et al., 2011). There has been a simultaneous, and connected, proliferation of digital technologies which intersect in various ways with walking and cycling, including: passive applications (apps) that can be downloaded to smartphones, tablets, and smartwatches that aid wayfinding; dedicated wearables that record activity such as steps (Fitbit, Nike+ Fuelband) or cycling activity (GPS devices); and more sophisticated multi-function wearables that also record multiple data-streams including biomarkers (such as heart rate). Many of these apps and devices either allow users to directly keep a record of their activities online or communicate with third party websites used to track and analyse physical activity, such as Strava or MapMyRide/Run.

The functions of these digital technologies are not necessarily novel: paper maps have existed for hundreds of years; the earliest pedometers date back to the eighteenth century; and mechanical devices could measure distances cycled or walked. There has never been an 'unmediated' way to walk or cycle (Laurier et al., 2016); the myriad practices that we label as 'walking' or 'cycling' have always been multiple and enmeshed in specific environmental-material-social networks. Thus mundane technologies, such as boots, both shape walking and are shaped by the kinds of walking done (Michael, 2000); the relationship between social groups, artefacts and problems of use have shaped particular bicycle designs and the emergence of cycling as a popular leisure activity (Bijker, 1995); and political and social structures intersect with the design and management of city streets or rural paths to encourage or discourage cycling or walking among different population groups (Bostock, 2001; Green, 2009; Steinbach et al., 2010; Larsen, 2017). However, digital technologies have evolved and diffused rapidly over the last decade, in ways often explicitly entangled with various health projects (Lupton, 2014). By the 1960s the Japanese Yamasa Corporation was mass producing affordable devices for measuring steps; these were included in games by the 2000s, and are now incorporated into wearable devices such as FitBits. These

innovations mean that devices can not only monitor users' activities but can also automatically upload this data to the internet (Lomborg and Frandsen, 2016). An emerging literature, currently spread across the fields of mobilities, geography, sports science, health research, computing and sociology, has begun to explore how these technologies have transformed the social practices of walking and cycling, and contributed to processes of biomedicalisation. Our aim in this paper is to review this emerging field of scholarship to outline key themes in empirical and theoretical research to date on digital technologies for walking and cycling; and to identify gaps and fruitful directions for further research.

Approach and scope

In mapping this field, we use a framing of biomedicalisation. This refers to a rather broader process than 'medicalisation'. If medicalisation is a useful shorthand to describe the ways in which walking and, more recently, cycling, have been brought within the medical gaze, and framed as legitimate domains of medical concern, biomedicalisation opens enquiry to explore how socio-technological shifts have transformed bodies, identities, communities and relationships, and how these, in turn, have transformed the networks associated with biomedicine (Clarke et al., 2003; Clarke, 2014). Biomedicalisation refers to processes of how techno-sciences and social forms (individuals, collectives, populations) are co-produced by and through each other. Thus, the concern is not just with interventions that attempt to promote health, but also with those sociotechnical ventures that seek to enhance the biological self. Clarke, and colleagues, identify five distinct processes which are involved: 1) economic shifts which have corporatized, commodified and stratified biomedicine, with the emergence of what they call 'Biomedical TechnoService Complex Inc' (i.e. multinational corporations and institutions that actively spread the reach and influence of the Western biomedical model and biomedicalisation processes); 2) the transformation of health itself through governmental strategies of surveillance and risk; 3) the 'technoscientization' of medicine through computer, pharmaceutical and genetic technologies; 4) transformations in the ways in which medical knowledge is produced and distributed; and 5) the transformations of bodies and identities such that "new individual and collective identities" are produced.

These processes are a useful starting point for exploring how digital technologies such as new apps or devices to monitor the body in motion do not necessarily drive change linearly,

nor unproblematically reflect a newly 'medicalised' sphere of mobility, but rather they are co-constitutive, with social actors, of hybrid and dispersed transformations. Thus, the question is not simply whether digital technologies have contributed to 'medicalising' mobility (by, for instance, turning walking and cycling into legitimate fields of public health enquiry), but rather what role digital technologies have played in the transformations and commodifications of social fields (such as commuting, walking, leisure cycling, or transport systems) and the bodies that occupy these fields. Lupton (2014) notes that the existing literature on digital technologies in health can be broadly divided into relatively uncritical accounts of how such technologies provide solutions for problems in the world and the more critical literature which addresses the social, moral, ethical and political consequences of technological developments. We focus here on the latter strand, and on one of the domains she identified: questions about the "role played by digital technologies in configuring and enacting concepts and experiences of embodiment, selfhood and social relations in the context of medicine and public health" (Lupton, 2014). Noting that there has been little engagement with apps and wearables in the domain of public health, Lupton (2013) explored the theoretical perspectives that could illuminate processes of the digital self. These include 'body projects of perfectibility'; healthism and responsibilisation of individuals as healthy consumers, in the ways in which technologies both assume and encourage citizens to be orientated to self-surveillance; visualisation and competitiveness; and metrification, in the ways in which numerical representations of bodies encourage a move from the 'haptic to the optic' as numbers become more meaningful than bodily sensations. In appraising the current field, an exploratory review was carried out by using bibliographic searches to identify empirical and theoretical contributions within and beyond sociology that addressed digital technologies and either walking or cycling; mapped the themes and key arguments in that literature, and identified potential areas of enquiry that were less well explored. We searched PubMed and google scholar for studies published between 2010 and March 2017. We searched using the terms 'digital', 'Fitbit', 'Strava', and other proprietary names, 'Apps' and 'cycle/cycling' or 'walking' in either the title, keywords or abstract. Those that were not focused significantly on digital technologies and cycling or walking were excluded. In addition, those that were out of the scope of a broadly sociological analysis were also excluded, leaving 45 articles for review. We also followed up a small number of influential bibliographic references, cited in our initial search, that fell

outside our preliminary time frame or that had not been retrieved in our initial search, and asked key scholars in various fields whether there were any key papers that had been missed.

Quantification: counting steps and tracking cycling

'Counting steps' is perhaps one of the most evident ways in which digital technologies have foregrounded the 'optic', and enabled the quantification of everyday mobility; an aspect of what has been called the 'datafication' of everyday life (Ruckstein and Schüll, 2017). The history of the pedometer, a device for counting steps, has been tightly bound to the reframing of walking as a health-promoting activity, and more specifically with the metrification of walking in a specific numerical goal of 10,000 steps as both aspirational and indicative of a 'healthy' lifestyle. This goal is built into many apps as a default, but the origins of the number lie, allegedly, in the history of the development of pedometer apps, and a slogan adopted by Japanese manufacturers of the *manpo-kei* (literally translated, 'ten thousand steps meter' (Tudor-Locke and Bassett, 2004)); the popularisation presumably due as much to the ease of the number to remember as any evidence-based link with health outcomes (Tudor-Locke and Bassett, 2004), as well as perhaps the satisfyingly 'collectable' virtue of the large numbers of discrete steps that can be accumulated. Cycling apps and devices typically record a greater variety of metrics: some external to the rider (speed, distance, height gained); others relating to biomedical aspects of the body (heart rate, cadence, power) – often combined to allow users to calculate an overall numeric 'fitness value' (Delaney, 2016). Thus the quantification of recorded steps or 'fitness value' allow users access to a simple numerical value with which to measure potential enhancements to the biological self.

Self-tracking apps are now explicitly heralded by researchers, practitioners and insurance companies as possible devices to help "objectively monitor and improve" patients' health (Higgins, 2016). Research on the efficacy of smartphone apps to measure steps and motivate behaviour change dates from 2007 (Bort-Roig et al., 2014). A significant contributor to the transformation of walking and cycling into discrete 'health behaviours' is the emerging sports science field, with a proliferation of studies on the impact of various digital technologies. Many apps are specifically designed to be "persuasive technologies" (Fritz et al., 2014): that is, they are explicitly intended to change the user's behaviour,

utilising one or more techniques such as goal setting, providing feedback on performance or self-monitoring (Middelweerd et al., 2014; Conroy et al., 2014; Bort-Roig et al., 2014.) These include representations of activity such as visualisations and motivational messages which act as conditional rewards for goals achieved (Fritz et al., 2014). Their efficacy in this regard is debated, with a number of supportive studies reporting that digital self-tracking and wearables lead to greater increases in physical activity than other technologies (Chan et al., 2004; Cadmus-Betram et al., 2015; Lewis et al., 2015) but other studies and reviews suggesting that effect sizes are modest (Fanning et al., 2012), may be short-lived (Gorm and Shklovski, 2015), are variable across social groups (Ho et al., 2013) and may not be demonstrably greater than other interventions (Lewis et al., 2015). Kiernan (2017) argues while tracking apps are widespread in their use across cyclists, a lack of theoretical understanding of the implications of these technologies mean they are effectively unexplored modalities.

Reconfiguring everyday activity

One discursive effect of this body of sports science research has been to reframe walking as "ambulatory behaviour" (Tudor-Locke et al., 2004). This renders physical behaviours (taking steps) as the key goal and universalises the step: any single step is equated with any other, and contributes equally to a health goal. The step must, therefore, be 'standardised', with validation processes undertaken by app developers (Evenson et al., 2015), but also by users. Gorm and Shklovski (2015) describe how teams of digital activity tracker users experimented to see what 'counted' and how, by comparing devices, and their own experience while jumping, taking longer or shorter strides, walking with each other or running. Orienting the user to those aspects of walking that are discrete and countable (the 'behaviour') elides other health effects of walking: both negative effects such as the risks that might accrue to mental health from walking in depressing streets (Bostock, 2001), or to physical health from traffic in dangerous streets (Freund and Martin, 2007); and positive ones, from the pleasures of ambling slowly or enjoying the sensory pleasures of the environment.

Sociological research has begun to explore what happens when walking is thus transformed into measurable 'steps', which can be tracked. A key effect is that walking becomes something 'noteworthy' rather than (literally) pedestrian. In a multi-disciplinary project in

which men were randomly assigned to a mobile phone app pedometer which either did or did not provide feedback on the number of steps taken, Harries and colleagues (Harries et al., 2013; Harries and Rettie, 2016; Harries et al., 2016) interviewed participating men to explore how the app transformed the place of walking within everyday practices. Taking a social practice approach, they first delineate integrative and dispersed walking practices. While integrative walking practices are orientated towards the practice of walking itself (in the case of hiking, for instance), dispersed practices are those embedded in other integrative practices, such as walking while shopping or working. In dispersed practices, teleoaffective orientations are tied to the integrative practice (shopping, working); 'walking' is not distinguished as a social entity in itself. One effect of the app, Harries and Rettie (2016) argue, is that it renders these dispersed practices as social entities in themselves: participants became not only aware of their incidental walking (as the steps they took literally 'counted'), but the app engendered new desires and subjectivities, as they became orientated towards 'taking a walk' as a practice in itself. Thus, the app foregrounded those health projects orientated towards biological fitness, such as taking physical exercise, while marginalising others, such as enhancing mental wellbeing through enjoying surroundings or taking a slow, meditative walk. These subjectivities enabled by the app had moral valence, with users berating themselves for 'lazy days' or congratulating themselves on meeting goals.

In contrast to walking, cycling in many contemporary urban environments is already 'extraordinary' as both commuter and leisure activity (Steinbach et al., 2011). The role of digital technologies in the biomedicalisation of cycling has thus been less orientated to transforming an everyday transport activity into 'exercise' given that, for many cyclists, the mundane commute is already understood as a contributor to health. Rather, the interest has been focused on how recording GPS and biological markers have reframed utility and recreational cycling as a competitive activity (Barrett, 2016; West, 2015) and, in doing so, foregrounded some health projects and potential users, while marginalising others. Strava, for instance, refers to its users as 'athletes', enables cyclists to track and share their times for specific segments of a route, and awards 'King/Queen of the Mountain' to those who ride the fastest (Smith and Treem, 2017).

Although not all users share their records (Smith and Treem, 2017), this reframing of cycling as 'athletic', and the seductions (for some) of competition, encourage potentially dangerous or risky mobilities (for the cyclist and others). Thus, these apps anticipate particular kinds of biomedical citizens, primarily those that prioritise physical fitness and achievement to enhance the biological self. Barrett (2016) notes the potential adverse effects of technologies which encourage ever-greater time spent on cycling, potentially damaging family relationships, or risking over-exertion. At a cultural level, the gamification of everyday cycling, which is enabled by apps such as Strava may further reinforce the risk-taking, competitive, and achievement-orientated resonances of cycling: resonances which have been noted as incongruent with many social identities (Steinbach et al., 2011).

One consequence of rendering the unremarkable, quotidian practices of mobility as noteworthy and recordable through self-tracking is that the boundaries between transport, leisure, competition and work become blurred. Thus Till (2014) proposes that "exercise activity is in the process of being reconfigured as work" because of the "ability to objectify and standardise the activities and capacities of heterogeneous bodies in such a fashion that value can be extracted" (p447). While users can collate and share information about their mobilities online, the corporations that own and control these online sites "can aggregate data or share with others within their 'corporate umbrella'" (p449) and disseminate aggregated data with third parties, with obvious appeal to many commercial organisations. This may be particularly significant for sites such as Strava and MapMyRide where users can enter significant information about themselves, their locations and the equipment they have purchased.

Creating and performing the healthy neoliberal citizen

If increased physical activity has been enfolded into many devices by design, other health effects flow from the subjectivities enabled by technologies. Lupton (2012) notes that digital self-tracking facilitates the neoliberal healthy self, as users are enrolled in projects of self-maximisation, responsibilisation and reflexivity (Lupton, 2012). Taking the Fitbit as an example, Fotopoulou and O'Riordan (2016) use media analysis and autoethnography to explore the role of wearables as "normative devices teaching users how to be good consumers and biocitizens" (p55). Noting that the device is both an artefact associated with particular practices, as well as a communication device that enrols users and audiences,

Fotopoulou and O'Riordan describe the ways in which the Fitbit is not only a digital health promotion device, using 'gamification' and other techniques to discipline the user in relation to a utopian health project of both normative expectations (about weight, activity and so on) and a perfectible self, but also has a pedagogical role in recruiting 'digital citizens', productive subjects who are willing and able to constantly (self) monitor, and feel remorse when (for instance) data is missed.

Apps and wearables can, then, be framed as contributing to contemporary bio-governance, with a role in creating biomedicalised digital citizens. Lomborg and Frandsen (2016) note that beyond the potentialities for deepening self-knowledge, through access to an "omnipresent personal coach", such self-tracking is primarily a communicative phenomenon, allowing users to share these achievements with an audience of other users. Thus, a lone cyclist can be part of a community even when not formally associated with a club or group. As a communicative activity, self-tracking is, they suggest a "lived informatics" (p4), with three dimensions. First, that of communication with the digital system (as users must learn how to integrate several technologies that 'speak to one another' – mobile phone, app, wearable device, online site) to provide feedback to the user. Second, data about the self and activity, over an extended period, are stored on online sites such as Strava, MapMyRide or Garmin Connect, enabling data to be presented back to the cyclist reflexively. Third, is communication with peers, as online data collections are shared with others, using social media functions of sharing, liking and commenting. Users can establish networks of other users and communicate aspects of their performance and experience (Groth, 2014).

The communicative aspects of digital technologies, therefore, enable new communities, of both known and unknown followers, to coalesce around cycling and, to a lesser extent, walking practices. Users can use competition to take 'responsibility' and self-reflect on their biological performativity. These competitive gamifications enact exclusions as well as inclusions. Gorm and Shklovksi (2016), for instance, describe a Danish workplace scheme in which employees sign up in teams to challenge to complete a step challenge, with successful teams entered into a lottery. Members become not only accountable to themselves for their activity levels (or lack thereof) but also to their colleagues, to both achieve step goals, but also to ensure positive experiences for all: non-participants reported

feeling excluded from workplace social life. Within the workplace, apps have a potentially broader role in reconfiguring the healthy citizen as productive as well as self-responsibilising. Drawing on interviews with those implementing self-tracking in workplaces in the UK, Till (2018) discusses the role of activity trackers in the growing corporate wellness movements. Again, work/leisure boundaries blur as companies enrol workers as agents in creating their own wellbeing, not only to foster healthy workplaces for increased productivity, but to encourage wellness in the population at large: an expansion of traditional capitalist roles into social philanthropy and bio-governance.

Hybrids and digital careers

Digital technologies produce new hybrids involving processes of mixing up and reassembling the categories of humans, things and places (Latour, 1993), such as the competitive cyclist commuter or the employee step-counting team. Developments in GPS technologies that locate users in physical space have facilitated widespread diffusion of wayfinding apps: not just generic ones such as Google Maps, but increasingly specialised ones which promote new kinds of walking and cycling (see, for instance, Allied Wayfinding, (2017) for visitors to Brighton, or Nickerson (2014) on an app for walkers on the Camino de Santiago). These innovations do more than replace paper-based technologies; they potentially reconfigure embodied experiences, interactions and memories in material environments (Kalin and Frith, 2016). Laurier et al. (2016), for instance, in an ethnomethodological study of walking with a wayfinding app, show how the specificities of the app (with its 'you are here' dot, the ability to rescale, orient, and suggest routes) and walking through a city reflexively co-construct each other. Following a pair of tourists during a short expedition to find a location, each wearing cameras, they show how by orientating to the map on the screen, the walkers jointly accomplish their mobility, with one taking a primary route finding role: walking becomes a hybridised activity in which progression, stops, turns, sense-making are achieved by the pair in conjunction with the smartphone and the app. 'Walking the dot' is one example, as pedestrians walk deliberately in one direction to check the dot on the screen moves. Mobile technologies are thus "implicated in pedestrian practices" (Laurier et al., 2016) in specific ways: the wayfinding app orientates the walker's, and the companion's, gaze differently from users of a paper map.

However, the emergence of stable hybrids is not inevitable and, even when stabilised, they may become unruly (Blok and Jensen, 2011). An important question is how far digital technologies get 'domesticated' (Carter et al., 2013): that is, how far they are routinely incorporated into life as stabilised objects, what trajectories of use exist, and with what effects. Technical artefacts are not obtained and then used unproblematically (Silverstone et al., 1992). Rather they must be 'tamed', which involves symbolic work (giving meaning), cognitive work (learning), and practical work (incorporating into daily life). The limited research to date on the digital careers of users and artefacts suggests the uneven processes of biomedicalisation, with effects that are contingent and multiple. First, some digital devices fail to stabilise and never become domesticated. Hybrids 'unravel', as devices end up abandoned (cf Larsen and Christensen, 2015) or never adopted. A good example comes from Copelton's (2010) study of a hospital-sponsored walking group for older women. This group is perhaps a classic case of the medicalisation of walking (recommended for health, organised by the hospital), with participants encouraged to use a pedometer to track their activity to encourage more walking. However, for the women in Copelton's study, although health was typically the motivator for starting with the group, what kept them coming was the sociability and camaraderie. This was fostered by engaging in joking conversation that focused on commonalities, and acceptance. Commonality was undermined by technologically-mediated step counting, which monitored individual achievements, and potentially set up competition and hierarchy. Few adopted the device. These were not, as Copelton notes, women who were necessarily averse to technology per se, given they utilised other technologies within the walking group and in their own homes. However, wearing a pedometer "is simultaneously a very intimate and social act that contributes to one's symbolic presentation of self" (p313): a presentation that was not (in this case) resonant with collective desired identities. Digital devices that prioritise facets of identity (competitiveness, health-orientation) not congruent with those prized by potential users may never get adopted.

Other devices fail at later points, after initial adoption (Gouveia et al., 2015). Psychological research has addressed the attenuation of effects over time, suggesting the diminishing psychological power of extrinsic 'rewards' such as badges for achieving walking or cycling goals, or 'fuel', compared with intrinsic rewards. Karapanos et al. (2016) note that

behaviour change techniques of self-monitoring and reinforcing are relatively 'primitive' and may be limited in long-term effectiveness. However, in an online questionnaire of US users of wearable trackers, even those longer-term users who had stopped deriving benefit from the numerical feedback, continued wearing the tracker: experiential benefits, such as enhancing autonomy, or increasing relatedness as other family members purchase trackers, they suggest, may foster the incorporation of the device into everyday life after the initial psychological benefits disappear. Digital careers are not uni-directional: the kinds of health constituted by technologies may change over time.

There is a growing body of research documenting how the incorporation of technologies into everyday routines can reframe how wellbeing is experienced. Fritz et al. (2014), in an interview study of the "value of system-provided metrics" for those who had used wearables (such as the Nike+ FuelBand or Fitbit) for at least three months. They describe the strong attachments users had to the device, and how the device changed their activities, in motivating additional walking when step counts were low for a day, for instance. The feedback elements (such as gaining 'Fuel' points on the Nike+ FuelBand) were reported as motivating in themselves, rather than for the underlying goal (such as getting fitter), even when the meaning of, for instance, a 'Fuel point' was not clear. Echoing Lupton's (2013) note on the move from haptic to optic ways of assessing subjective health states, numerical data became more important than the activity they represented. Forgetting the monitoring device, or engaging in activities which were not recorded, could, therefore, be intensely annoying: participants described not enjoying activities which were earning no 'credit'. One described the declining utility of a FitBit as her fitness increased and she wanted to spend more time doing weights at the gym, rather than walking to achieve the step goal. Thus, technologies can constrain, as well as enable, fitness activities. Some users did not use the social features of the device, but those that did cited the competition as an additional motivator to take more steps, generally finding an online community, rather than real-life friends, but noting that finding the 'right' peers to compete against was challenging. These technologies can, then, change the meaning of activities for users, with pleasure being suppressed or heightened depending on whether the device legitimates the activity or not, and create new communities.

Finally, once hybrids become taken for granted, they can change understandings of what the body is, and what it can and should do. Nansen (2008) considers the role of pedometers (which only measures steps taken), and later accelerometers (which can also record speed, and distance and other features) as mediators of walking practices. Explanations reliant on governmentality, or healthism, he suggests, underplay how the technology itself plays a role as an active agent in transforming practices. Drawing instead on Latour's Actor-Network Theory to consider how pedometers and walking practices co-constitute each other, he points to a contrast between the gym treadmill and the pedometer to show how the latter configures walking as a practice spread over space and time, into 'everyday life' rather than the delineated location of 'exercise'. If the treadmill fostered a Fordist body, disciplined with a spatial and time-limited routine, the pedometer encourages a self-governing body which is constantly performing, within eroded boundaries of work and leisure, and in which exercise is reconfigured as 'physical activity', and incorporated into daily life. The pedometer assists with this paradigm shift, in recording activity continuously throughout waking time, reminding the user to be active, and exhorting them implicitly to 'walk more'. It is recruited into the challenges of emergent and dynamic rhythms of temporality, in which the user must incorporate ever more physical activity within an active life. Thus, the physical body and the pedometer collaborate as a hybrid within what Nansen suggests is a new "anatomo- and chrono-politics" of convergence time.

Discussion

A vibrant research field has emerged, spread across a number of disciplines, which explores the new identities and communities that have been created, ignored, inhibited and legitimated by practices such as self-tracking and social media sharing of the biological self; the digital careers of users and the new hybrids that emerge as old technologies (bicycles, maps), new technologies (wearables, apps) and bodies come together in specific environments. We have identified four overlapping themes in this literature: quantification; reconfiguring everyday activity; creating and performing the healthy neoliberal citizen; and hybrids and digital careers. This is inevitably an emergent field, which is to date perhaps richer in theoretical framing and speculative research agendas than detailed empirical research and, as Schwanen (2015) notes, there may be little that is generalizable from specific case studies. However, in bringing together case studies, this review has identified

the key role digital technologies play in the biomedicalisation of everyday mobility, such that walking and cycling are increasingly commodified in various ways: as discrete 'behaviours' which can contribute to projects of enhancing the biological self; and potentially as 'work', with surplus value that can (in theory at least) be appropriated by commercial interests. There are also some potential avenues that remain relatively underexplored to date, and which would be fruitful areas for future enquiry.

First, much of the sociological research on digital technologies for active mobility has utilised theoretical framings from Science and Technology Studies, governmentality, and social practice traditions, which have been productive approaches. However, this has perhaps resulted in a paucity of sociological research taking political economy approaches, beyond noting the extraction of micro-surplus of 'work' (cf Till, 2014). The economic processes of commodification identified by Clarke et al. (2003) as core processes of biomedicalisation have been relatively neglected in the arena of digital technologies for walking and cycling. Markets for these products are large, and increasingly entangled with other markets for commodified health: through health and other insurance markets; through sales of data to transport planners (Romanillos et al., 2016); through the development of workplace health promotion (Meershoek and Horstman, 2016; Christophersen et al., 2015; Till, 2018) and through biomedical research (Munos et al., 2016), for example. There is, then, considerable potential for research which explores in detail how medical markets develop to incorporate 'mHealth' (Lupton, 2013) and, more specifically, documents who gains and who loses by the development of digital technologies. As Christophersen et al. (2015) note, in relation to private health insurance and wearables, some have more potential to gain than others, with ethical and equity consequences from the use of health tracking data in setting insurance premiums.

Second, the majority of research has rightly focused on what people and technology hybrids *do*, regarding what is achieved and how. Apart from studies of when technologies fail to be adopted (e.g., Copelton, 2010), there is little on what they fail to do, or what kinds of 'resistance' might be offered: the ways in which the commodification of biovalue specifically, or digital health projects in general, might be agentially subverted, mitigated or resisted by users as individuals or collectives. Rather like the emergence of 'sousveillence' (using technology such as wearables to 'watch the watchers' (Mann and Ferenbok, 2013)),

cycling and walking involve communities who resist the commercialisation of, for instance, mapping software (such as cyclist communities making creative-commons maps as alternatives to commercially available ones), or who have side-stepped digital developments[i]. Research on apps has, inevitably, focused on users, or potential users, and indeed often on 'superusers', who are particularly highly engaged (van Mierlo et al., 2015). It is harder to research the 'non-user', as by even inviting their reflections, they are positioned vis a vis technology: Christophersen et al. (2015) note that in a context where trackers are offered to all in a workplace, refusing to wear one will have consequences. More generally, Ruckstein and Schüll (2017) argue that both users of digital technologies and research participants in studies tend to be the "wealthy, educated and cosmopolitan citizens" least likely to be affected by the poor health effects of inadequate physical exercise, and they are most likely to be in the global north. There are, then, important questions around whose bodies remain untracked, and unmonitored, and what effects this has on both the content of Big Data collated and on individual health projects. For what kinds of people are digital technologies just 'unthinkable'? What biomarkers, or activities, remain unmeasured, and with what effects?

Third, we have summarised the rich seam of comment in the published literature on the biomedicalisation of walking and cycling practices regarding how they are transformed by digital technologies. However, there has been little research on the potential for these domains of 'walking' or 'cycling' to be themselves disrupted through the emergence of new hybrid mobilities as digital technologies interact with other things, people and species over time in environments to unsettle what walking or cycling are. Debates over uncomfortable boundary-crossing and the emergence of yet more 'unruly hybrids' such as electric bikes, self-driving cars, or shared road spaces illustrate the tensions that emerge from attempts to keep things and projects apart and thus maintain the existence of 'pure categories' (Latour,1993).

Conclusion

Digital technologies have transformed everyday practices of walking and cycling. We have used a framing of biomedicalisation to review recent scholarship on these partial, contingent and diverse transformations, including those of reframing quotidian pedestrianism into exercise, and utility cycling into athletic competition. We have pointed to

some of the research that has begun to explore which kinds of health projects are being foregrounded by digital technologies, and with what effects. In conclusion, we suggest a useful way of building on this vibrant early work will be to develop inter-disciplinary studies that can draw on computing, sociology, economics and other disciplines to progress our understanding of the political economy of digital health, and the ways in which resistance is being enacted, particularly around new emergent hybrids.

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[i] For instance, AUDAX, a long distance cycling club, has checkpoints validated non-digitally, and issues an A4 newsletter